

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : KOBE STEEL LTD

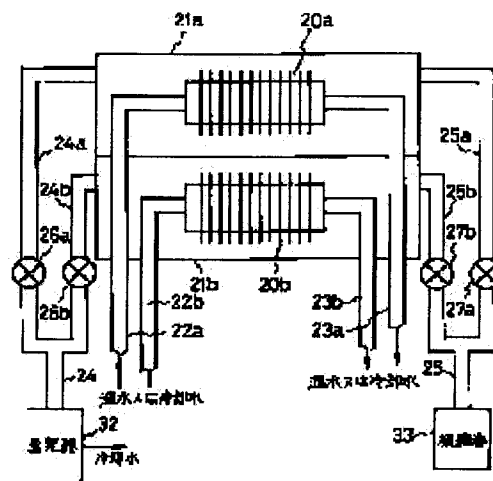
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(72)Inventor : IWAMOTO HIROYUKI
TAKAGAKI MASAKAZU

(54) ADSORPTION TYPE REFRIGERATOR

(57)Abstract:

PURPOSE: To provide an adsorption type refrigerator in which an efficiency can be improved by improving a coefficient of performance while utilizing the advantage of the refrigerator of a low running cost.
CONSTITUTION: A moisture adsorbing material is disposed on an outer surface of a heat exchanging member 20 including fins to adsorb moisture in contact of the air evaporated from an evaporator 32 with the outer surface of the one heat exchanging member 20b. Adsorption heat generated at this time is removed by cooling water which flows in the member. On the other hand, warm drain is fed to the other heat exchanging member 20a to be heated, and the material is desorbed. The air containing desorbed moisture is condensed by a condenser 33. Regenerating step and adsorbing step of the members 20a, 20b are alternately executed to continuously make chilled water by the evaporator 32.



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CLAIMS

[Claim(s)]

[Claim 1] The tubed heat exchange member by which water adsorption material has been arranged at the outside-surface part, and an evaporator, An adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, The adsorption equation refrigerator characterized by having a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser which condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.

[Claim 2] At least two sets of the tubed heat exchange members by which water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, The adsorption equation refrigerator characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.

[Claim 3] Said heat exchange member is an adsorption equation refrigerator according to claim 1 or 2 characterized by preparing two or more fins in that outside surface, and the front face of this fin constituting said outside surface of said heat exchange member.

[Claim 4] Said adsorption material is an adsorption equation refrigerator according to claim 1 or 2 characterized by being at least one sort chosen from the group which consists of silica gel, a zeolite, an activated alumina, and activated carbon.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention uses the latent heat of vaporization of the refrigerant within a low-pressure well-closed container, makes the generated refrigerant steam stick to adsorption material, and relates to an adsorption equation refrigerator effective in manufacturing cold water about 5 degrees C or more especially using heat exchange members, such as a plate fin mold heat-transfer element, shell, a tube mold heat-transfer element, and an erotic fin mold heat-transfer element, about the adsorption equation refrigerator which a refrigerant is evaporated continuously and obtains cold energy.

[0002]

[Description of the Prior Art] There are a technique of manufacturing cold water by the latent heat of vaporization in case a refrigerant evaporates as a means to manufacture cold water, using a steamy compression refrigerating machine, a technique of evaporating water within the container decompressed so that water might evaporate at low temperature using an absorption refrigerator, and manufacturing cold water by the latent heat of vaporization, and a technique of manufacturing cold water with an adsorption equation refrigerator by making the pellet of silica gel into adsorption material.

[0003] Although the steamy compression refrigerating machine is generally conventionally used for manufacture of cold water, this steamy compression refrigerating machine has the trouble that consumption energy is high, in order that it is going to be contrary to the request of the latest dechlorofluocarbon since chlorofluocarbon is used, and the heat of condensation may carry out [and] condensation removal of the large moisture.

[0004] On the other hand, although an absorption refrigerator does not produce the problem of chlorofluocarbon, as compared with a steamy compression refrigerating machine, the high pressure steam of about 8 kgf/cm²G is needed in effectiveness being bad and gathering this frozen effectiveness. An installation will be restrained, and equipment enlarges the feeder of such a high pressure steam as compared with a steamy compression refrigerating machine, and it has the difficulty that maintenance is difficult.

[0005] Since the adsorption equation refrigerator is using silica gel for adsorption material, by using thermal wastewater, such as works and a cogeneration system, as compared with an absorption refrigerator, although effectiveness is bad, a running cost becomes very low and it has the advantage that there is little change of the effectiveness by fluctuation of the warm water temperature at the time of desorption.

[0006] The evaporator 1 which carries out an adsorption process, and the adsorption material heat exchanger 3 are connected in [the condenser 2 and the adsorption material heat exchanger 4 which carry out a playback process again] airtight, and this adsorption equation refrigerator is held at a high vacuum, as shown in drawing 3 (the number for clean energy February, 1993 the 35th thru/or 40 pages). Although two heat exchangers 3 and 4 are formed, a playback process and an adsorption process are carried out by turns, and, thereby, each of these is connected with an evaporator 1 or a condenser 2 by turns. The refrigerant 8 of T_e exists [temperature] in the interior of an evaporator 1, and the refrigerant 8 of T_c exists [temperature] in a condenser 2. This refrigerant is water. Moreover, although the adsorption material 7 is stored in the adsorption material heat exchanger 3 and 4, as for the adsorption material 7 in the adsorption material heat exchanger 4 of a playback process, the temperature of the temperature of the adsorption material 7 in T_r and the adsorption material heat exchanger 3 of an adsorption process is T_a . This adsorption material is silica system solid-state adsorption material.

[0007] At a playback process, from a heat source, the refrigerant to which that temperature was rising from T_a to T_r in response to heat, and it was sticking serves as a steam, desorption of the adsorption material 7 of the adsorption material heat exchanger 4 is carried out, and this steam serves as water with a condenser 2 at condensation temperature T_c (pressure P_c). By this actuation, the water content of adsorption material shifts to q_a from q_b in an amount-of-adsorption diagram, such as being shown in drawing 4.

[0008] Moreover, in an adsorption process, since the percentage of saturatel water content of adsorption material increases the adsorption material 7 in the adsorption material heat exchanger 3 from q_a to q_b by being cooled until temperature is set to T_a from T_r with cooling water etc., a refrigerant takes heat from the outside of a system, evaporates it at the evaporation temperature T_e (pressure P_e) in an evaporator 1, and is adsorbed by the adsorption material 7. Moreover, since the heat of adsorption generated at the time of adsorption is taken by cooling water, temperature is held at T_a and the adsorption material 7 is continuously adsorbed by the adsorption material 7 in a refrigerant. When two sets of heat exchangers 3 and 4 repeat such a process by turns, cold water is continuously obtained from an evaporator 1.

[0009]

[Problem(s) to be Solved by the Invention] However, this conventional adsorption equation refrigerator has the difficulty that cold-water manufacture effectiveness is low. If 29 degrees C and warm water inlet temperature are set into 75 degrees C and a steam is set [12 degrees C and refrigerating capacity] to 8 kgf/cm²G for 10USRT(s) (30240 kcal/H) and cooling water inlet temperature at 14 degrees C and a cold-water outlet, compressor capacity is sometimes for example, excellent [it is a cold-water inlet port about cold-water conditions, and / with 3.4] in the coefficient of performance COP in 7.5kW and the maximum stream flow in the case of the steamy compression refrigerating machine 3/12m. In addition, in a refrigerator, although a heating value Q is pumped up, this coefficient of performance is the index the work W of which to consume, and expresses the effectiveness of a refrigerator. However,

in this steamy compression refrigerating machine, if power is required to drive a compressor and the generating efficiency for it is taken into consideration, it will be thought that a coefficient of performance COP becomes about one. On the other hand, steam consumption of an absorption refrigerator is 45kg/o'clock, and a coefficient of performance is 1.2.

[0010] On the other hand, an adsorption equation refrigerator has a very low coefficient of performance as compared with 0.56, and a steamy compression refrigerating machine and an absorption refrigerator.

[0011] It aims at this invention being made in view of this trouble, and offering the adsorption equation refrigerator which can raise a coefficient of performance and can raise effectiveness, employing efficiently the advantage of the adsorption equation refrigerator that a running cost is low.

[0012]

[Means for Solving the Problem] The tubed heat exchange member by which, as for the 1st adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part, An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, It is characterized by having a cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser that condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.

[0013] At least two sets of the tubed heat exchange members by which, as for the 2nd adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, It is characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.

[0014] In this case, to said heat exchange member, two or more fins are prepared in that outside surface, and it is desirable that it is that from which the front face of this fin also constitutes said outside surface of said heat exchange member.

[0015] Moreover, as said adsorption material, there is silica gel, a zeolite, an activated alumina, or activated carbon.

[0016]

[Function] In this invention, prepare adsorption material in the outside surface of a tubed heat exchange member, and the interior of a heat exchange member is made to carry out conduction of a thermal fluid or the cooling fluid, and the adsorption material of the outside surface of a heat exchange member is heated, or it cools. By this, adsorption material is heated, a playback process is carried out in the heat exchange member in which thermal fluids, such as 75-degree C thermal wastewater, are carrying out conduction, and desorption of the moisture is carried out. This desorption moisture serves as a steam, goes into a condenser, and is cooled and condensed with a condenser. On the other hand, conduction of the steam generated in the evaporator is contacted and carried out to the adsorption material of a heat exchange member, and it is adsorbed by adsorption material in the moisture. In an evaporator, the cold water which the latent heat of vaporization was taken and was cooled is obtained. In this adsorption process, since the interior of a heat exchange member is made to carry out conduction of the cooling fluid, adsorption material does not carry out a temperature up with a heat of adsorption, adsorption effectiveness does not necessarily fall, it is always efficient and an adsorption process is carried out. Thus, in this adsorption process, while heat exchange is carried out inside the outside-surface side of a tubed heat exchange member and an adsorption process and a playback process are carried out by turns, since adsorption material is cooled with the cooling fluid, adsorption effectiveness is high in this invention. Therefore, the extremely excellent frozen effectiveness can be acquired and a coefficient of performance can be raised.

[0017]

[Example] Hereafter, the example of this invention is concretely explained with reference to an attached drawing.

Drawing 1 is the front view showing the heat exchange member 20 of the adsorption refrigerator concerning the example of this invention. Fitting of two or more aluminum plate fins 12 is carried out to the heat exchange tubing (copper tube) 11. And the water adsorption material 13 is arranged all over the peripheral face of these copper tubes 1, and the front face of a fin 12. This adsorption material 13 can apply an acrylic adhesiveness binder all over the peripheral face of a copper tube 11, and the front face of a fin 12, and can form it by installing it on this acrylic adhesion material binder film, as a silica gel particle is embedded. Moreover, the powder of silica gel is kneaded with water glass, and after extruding and applying this to the peripheral face of a copper tube 11, and the front face of a fin 12, desiccation baking of the part for water glass can be carried out, and adsorption material can be prepared by fixing silica gel powder and water glass on a fin front face etc. Anyway, what is necessary is just to fix by applying the powder or particle of adsorption material to the front face of a heat exchange member, or pasting up. As adsorption material, a zeolite, activated carbon, an activated alumina, etc. are out of silica gel.

[0018] Moreover, although the heat exchange member shown in drawing 1 is the heat-transfer element of a plate fin mold, the heat-transfer element of not only a such type thing but a shell and a tube mold, or an erotic fin mold etc. can also be used, and the heat-transfer element of the shape of single tubing which does not have a fin further may be used.

[0019] The adsorption equation refrigerator of this example is constituted as shown in drawing 2 using this heat exchange member 20 (20a, 20b). It is contained in airtight in housing 21a and 21b, and, as for each heat exchange members 20a and 20b, warm water or cooling water is supplied through Piping 22a and 22b inside these heat exchange members 20a and 20b, respectively. This warm water or cooling water carries out conduction of the interior of the heat exchange members 20a and 20b, and after it heats the heat exchange members 20a and 20b or cools, it is discharged through Piping 23a and 23b. These piping 22a, 22b, 23a, and 23b is drawn by the exterior of Housing 21a and 21b.

[0020] The piping 24a and 24b which is open for free passage in housing 21a and 21b is connected with one edge of

Housing 21a and 21b, and Piping 25a and 25b is connected with the other-end section of Housing 21a and 21b. Piping 24a and 24b is connected with piping 24 by each, and Housing 21a and 21b is connected with the evaporator 32 through these piping 24, 24a, and 24b. On the other hand, Piping 25a and 25b is connected with piping 25 by each, and Housing 21a and 21b is connected with the condenser 33 through these piping 25, 25a, and 25b.

[0021] The closing motion valves 26a and 26b are formed in Piping 24a and 24b, and the closing motion valves 27a and 27b are formed in Piping 25a and 25b. Each of these housing and piping are held airtightly. Moreover, the inside of housing 21a and 21b is held at the vacua.

[0022] Next, actuation of the adsorption equation refrigerator constituted in this way is explained. First, heat exchange member 20a presupposes that playback process and heat exchange member 20b is carrying out the adsorption process. The closing motion valves 26a and 27b are made close, and the closing motion valves 26b and 27a are made open. Moreover, the interior of heat exchange member 20a is made to carry out conduction of the warm water through Piping 22a and 23a. This warm water can use what is discharged as thermal wastewater at works. Moreover, the interior of heat exchange member 20b is made to carry out conduction of the cooling water through Piping 22b and 23b. This cooling water can use the about 29-degree C water supplied from a cooling tower.

[0023] If it does so, the interior of an evaporator 32 and housing 21b will be open for free passage, the adsorption material by which the refrigerant steam which evaporated with the evaporator 32 was formed in the outside surface of heat exchange member 20b will be contacted, and adsorption material will be adsorbed in a refrigerant steam. As a result of moisture's adsorbing in the adsorption material of this heat exchanger 20b, in an evaporator 32, evaporation advances further. In this case, since cooling water is carrying out conduction of the interior of heat exchanger 20b and heat exchanger 20b is cooled, even if generation of heat arises by the adsorption reaction of adsorption material, since adsorption material is cooled, adsorption effectiveness does not fall.

[0024] Thus, as a result of evaporation advancing with an evaporator 32, water is cooled by the latent heat of vaporization and cold water is manufactured.

[0025] On the other hand, since thermal wastewater is carrying out conduction of the interior in heat exchange member 20a, the adsorption material is heated and adsorption material carries out desorption of the moisture to which it was sticking at low temperature comparatively to the bottom of a vacuum. Since housing 21a is open for free passage with the condenser 33, it is cooled with a condenser 33 and moisture condenses the refrigerant steam which carried out desorption from adsorption material. In heat exchanger 20a, the desorption of moisture advances further by condensation of this moisture, and adsorption material is reproduced.

[0026] Thus, after playback of adsorption material is completed in heat exchange member 20a and water adsorption is completed in heat exchange member 20b, the closing motion valves 26a and 27b are made open, and the closing motion valves 26b and 27a are made close. If it does so, an adsorption process will be carried out in heat exchange member 20a, and a playback process will be carried out in heat exchange member 20b. Thus, cold water is continuously manufactured from an evaporator 32 by carrying out a playback process and an adsorption process by turns by the heat exchange members 20a and 20b.

[0027] In this example, since the heat exchange member 20 (20a, 20b) has a fin 12 like drawing 1 and the adsorption material 13 is formed also in this fin 12, an adsorption area is large, it is efficient, and moisture adsorbs. Moreover, in an adsorption process, since cooling water carried out conduction of the interior of the heat exchange member 20 and adsorption material is cooled, even if generation of heat by the adsorption reaction arises, adsorption effectiveness does not fall and high adsorption effectiveness is maintained. Consequently, according to the adsorption equation refrigerator of this example, it is very efficient and cold water can be obtained. For this reason, a coefficient of performance is high.

[0028] Next, drawing 1 and the adsorption equation refrigerator shown in 2 are actually manufactured, and the result of having asked for the coefficient of performance is explained. The fin pitch of this heat exchange member is 3.5mm. The heating area of each heat exchange member is 2.29m, and the change of a closing motion valve, i.e., the change to a playback process and an adsorption process, is for 5 minutes. The acrylic adhesiveness binder was applied all over the plate fin made from aluminum, and the silica gel whose grain size is 20 thru/or 35 meshes was pasted up on the front face two times 680 g/m. A heat carrier is 75-degree C thermal wastewater, and the cooling water of the medium inside the heat exchange tubing 1 is cooling tower water.

[0029] Consequently, that that whose warm water was 75 degrees C at the entrance fell to 70 degrees C at the outlet, and cold water's was [that] 14 degrees C at the entrance fell to 12 degrees C at the outlet. The heating value by the side of warm water was 63kW, and the heating value by the side of cooling water was 82.5kW. Consequently, coefficients of performance were $82.5 / 63 = 1.31$.

[0030]

[Effect of the Invention] The coefficient of performance can be raised more than the coefficient of performance of other steamy compression refrigerating machines and an absorption refrigerator, employing efficiently the advantage that the running cost of an adsorption equation refrigerator is low according to this invention, as explained above. For this reason, this invention does so the outstanding effectiveness that it is very efficient and cold water can be manufactured.

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TECHNICAL FIELD

[Industrial Application] This invention uses the latent heat of vaporization of the refrigerant within a low-pressure well-closed container, makes the generated refrigerant steam stick to adsorption material, and relates to an adsorption equation refrigerator effective in manufacturing cold water about 5 degrees C or more especially using heat exchange members, such as a plate fin mold heat-transfer element, shell, a tube mold heat-transfer element, and an erotic fin mold heat-transfer element, about the adsorption equation refrigerator which a refrigerant is evaporated continuously and obtains cold energy.

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PRIOR ART

[Description of the Prior Art] There are a technique of manufacturing cold water by the latent heat of vaporization in case a refrigerant evaporates as a means to manufacture cold water, using a steamy compression refrigerating machine, a technique of evaporating water within the container decompressed so that water might evaporate at low temperature using an absorption refrigerator, and manufacturing cold water by the latent heat of vaporization, and a technique of manufacturing cold water with an adsorption equation refrigerator by making the pellet of silica gel into adsorption material.

[0003] Although the steamy compression refrigerating machine is generally conventionally used for manufacture of cold water, this steamy compression refrigerating machine has the trouble that consumption energy is high, in order that it is going to be contrary to the request of the latest dechlorofluorocarbon since chlorofluorocarbon is used, and the heat of condensation may carry out [and] condensation removal of the large moisture.

[0004] On the other hand, although an absorption refrigerator does not produce the problem of chlorofluorocarbon, as compared with a steamy compression refrigerating machine, the high pressure steam of about 8 kgf/cm²G is needed in effectiveness being bad and gathering this frozen effectiveness. An installation will be restrained, and equipment enlarges the feeder of such a high pressure steam as compared with a steamy compression refrigerating machine, and it has the difficulty that maintenance is difficult.

[0005] Since the adsorption equation refrigerator is using silica gel for adsorption material, by using thermal wastewater, such as works and a cogeneration system, as compared with an absorption refrigerator, although effectiveness is bad, a running cost becomes very low and it has the advantage that there is little change of the effectiveness by fluctuation of the warm water temperature at the time of desorption.

[0006] The evaporator 1 which carries out an adsorption process, and the adsorption material heat exchanger 3 are connected in [the condenser 2 and the adsorption material heat exchanger 4 which carry out a playback process again] airtight, and this adsorption equation refrigerator is held at a high vacuum, as shown in drawing 3 (the number for clean energy February, 1993 the 35th thru/or 40 pages). Although two heat exchangers 3 and 4 are formed, a playback process and an adsorption process are carried out by turns, and, thereby, each of these is connected with an evaporator 1 or a condenser 2 by turns. The refrigerant 8 of T_e exists [temperature] in the interior of an evaporator 1, and the refrigerant 8 of T_c exists [temperature] in a condenser 2. This refrigerant is water. Moreover, although the adsorption material 7 is stored in the adsorption material heat exchanger 3 and 4, as for the adsorption material 7 in the adsorption material heat exchanger 4 of a playback process, the temperature of the temperature of the adsorption material 7 in T_r and the adsorption material heat exchanger 3 of an adsorption process is T_a . This adsorption material is silica system solid-state adsorption material.

[0007] At a playback process, from a heat source, the refrigerant to which that temperature was rising from T_a to T_r in response to heat, and it was sticking serves as a steam, desorption of the adsorption material 7 of the adsorption material heat exchanger 4 is carried out, and this steam serves as water with a condenser 2 at condensation temperature T_c (pressure P_c). By this actuation, the water content of adsorption material shifts to q_a from q_b in an amount-of-adsorption diagram, such as being shown in drawing 4.

[0008] Moreover, in an adsorption process, since the percentage of saturatel water content of adsorption material increases the adsorption material 7 in the adsorption material heat exchanger 3 from q_a to q_b by being cooled until temperature is set to T_a from T_r with cooling water etc., a refrigerant takes heat from the outside of a system, evaporates it at the evaporation temperature T_e (pressure P_e) in an evaporator 1, and is adsorbed by the adsorption material 7. Moreover, since the heat of adsorption generated at the time of adsorption is taken by cooling water, temperature is held at T_a and the adsorption material 7 is continuously adsorbed by the adsorption material 7 in a refrigerant. When two sets of heat exchangers 3 and 4 repeat such a process by turns, cold water is continuously obtained from an evaporator 1.

[0009]

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EFFECT OF THE INVENTION

[Effect of the Invention] The coefficient of performance can be raised more than the coefficient of performance of other steamy compression refrigerating machines and an absorption refrigerator, employing efficiently the advantage that the running cost of an adsorption equation refrigerator is low according to this invention, as explained above. For this reason, this invention does so the outstanding effectiveness that it is very efficient and cold water can be manufactured.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, this conventional adsorption equation refrigerator has the difficulty that cold-water manufacture effectiveness is low. If 29 degrees C and warm water inlet temperature are set into 75 degrees C and a steam is set [12 degrees C and refrigerating capacity] to 8 kgf/cm²G for 10USRT(s) (30240 kcal/H) and cooling water inlet temperature at 14 degrees C and a cold-water outlet, compressor capacity is sometimes for example, excellent [it is a cold-water inlet port about cold-water conditions, and / with 3.4] in the coefficient of performance COP in 7.5kW and the maximum stream flow in the case of the steamy compression refrigerating machine 3/12m. In addition, in a refrigerator, although a heating value Q is pumped up, this coefficient of performance is the index the work W of which to consume, and expresses the effectiveness of a refrigerator. However, in this steamy compression refrigerating machine, if power is required to drive a compressor and the generating efficiency for it is taken into consideration, it will be thought that a coefficient of performance COP becomes about one. On the other hand, steam consumption of an absorption refrigerator is 45kg/o'clock, and a coefficient of performance is 1.2.

[0010] On the other hand, an adsorption equation refrigerator has a very low coefficient of performance as compared with 0.56, and a steamy compression refrigerating machine and an absorption refrigerator.

[0011] It aims at this invention being made in view of this trouble, and offering the adsorption equation refrigerator which can raise a coefficient of performance and can raise effectiveness, employing efficiently the advantage of the adsorption equation refrigerator that a running cost is low.

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MEANS

[Means for Solving the Problem] The tubed heat exchange member by which, as for the 1st adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part, An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, It is characterized by having a cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser that condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.

[0013] At least two sets of the tubed heat exchange members by which, as for the 2nd adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, It is characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.

[0014] In this case, to said heat exchange member, two or more fins are prepared in that outside surface, and it is desirable that it is that from which the front face of this fin also constitutes said outside surface of said heat exchange member.

[0015] Moreover, as said adsorption material, there is silica gel, a zeolite, an activated alumina, or activated carbon.

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OPERATION

[Function] In this invention, prepare adsorption material in the outside surface of a tubed heat exchange member, and the interior of a heat exchange member is made to carry out conduction of a thermal fluid or the cooling fluid, and the adsorption material of the outside surface of a heat exchange member is heated, or it cools. By this, adsorption material is heated, a playback process is carried out in the heat exchange member in which thermal fluids, such as 75-degree C thermal wastewater, are carrying out conduction, and desorption of the moisture is carried out. This desorption moisture serves as a steam, goes into a condenser, and is cooled and condensed with a condenser. On the other hand, conduction of the steam generated in the evaporator is contacted and carried out to the adsorption material of a heat exchange member, and it is adsorbed by adsorption material in the moisture. In an evaporator, the cold water which the latent heat of vaporization was taken and was cooled is obtained. In this adsorption process, since the interior of a heat exchange member is made to carry out conduction of the cooling fluid, adsorption material does not carry out a temperature up with a heat of adsorption, adsorption effectiveness does not necessarily fall, it is always efficient and an adsorption process is carried out. Thus, in this adsorption process, while heat exchange is carried out inside the outside-surface side of a tubed heat exchange member and an adsorption process and a playback process are carried out by turns, since adsorption material is cooled with the cooling fluid, adsorption effectiveness is high in this invention. Therefore, the extremely excellent frozen effectiveness can be acquired and a coefficient of performance can be raised.

[Translation done.]

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EXAMPLE

[Example] Hereafter, the example of this invention is concretely explained with reference to an attached drawing. Drawing 1 is the front view showing the heat exchange member 20 of the adsorption refrigerator concerning the example of this invention. Fitting of two or more aluminum plate fins 12 is carried out to the heat exchange tubing (copper tube) 11. And the water adsorption material 13 is arranged all over the peripheral face of these copper tubes 1, and the front face of a fin 12. This adsorption material 13 can apply an acrylic adhesiveness binder all over the peripheral face of a copper tube 11, and the front face of a fin 12, and can form it by installing it on this acrylic adhesion material binder film, as a silica gel particle is embedded. Moreover, the powder of silica gel is kneaded with water glass, and after extruding and applying this to the peripheral face of a copper tube 11, and the front face of a fin 12, desiccation baking of the part for water glass can be carried out, and adsorption material can be prepared by fixing silica gel powder and water glass on a fin front face etc. Anyway, what is necessary is just to fix by applying the powder or particle of adsorption material to the front face of a heat exchange member, or pasting up. As adsorption material, a zeolite, activated carbon, an activated alumina, etc. are out of silica gel.

[0018] Moreover, although the heat exchange member shown in drawing 1 is the heat-transfer element of a plate fin mold, the heat-transfer element of not only a such type thing but a shell and a tube mold, or an erotic fin mold etc. can also be used, and the heat-transfer element of the shape of single tubing which does not have a fin further may be used.

[0019] The adsorption equation refrigerator of this example is constituted as shown in drawing 2 using this heat exchange member 20 (20a, 20b). It is contained in airtight in housing 21a and 21b, and, as for each heat exchange members 20a and 20b, warm water or cooling water is supplied through Piping 22a and 22b inside these heat exchange members 20a and 20b, respectively. This warm water or cooling water carries out conduction of the interior of the heat exchange members 20a and 20b, and after it heats the heat exchange members 20a and 20b or cools, it is discharged through Piping 23a and 23b. These piping 22a, 22b, 23a, and 23b is drawn by the exterior of Housing 21a and 21b.

[0020] The piping 24a and 24b which is open for free passage in housing 21a and 21b is connected with one edge of Housing 21a and 21b, and Piping 25a and 25b is connected with the other-end section of Housing 21a and 21b. Piping 24a and 24b is connected with piping 24 by each, and Housing 21a and 21b is connected with the evaporator 32 through these piping 24, 24a, and 24b. On the other hand, Piping 25a and 25b is connected with piping 25 by each, and Housing 21a and 21b is connected with the condenser 33 through these piping 25, 25a, and 25b.

[0021] The closing motion valves 26a and 26b are formed in Piping 24a and 24b, and the closing motion valves 27a and 27b are formed in Piping 25a and 25b. Each of these housing and piping are held airtightly. Moreover, the inside of housing 21a and 21b is held at the vacua.

[0022] Next, actuation of the adsorption equation refrigerator constituted in this way is explained. First, heat exchange member 20a presupposes that playback process and heat exchange member 20b is carrying out the adsorption process. The closing motion valves 26a and 27b are made close, and the closing motion valves 26b and 27a are made open. Moreover, the interior of heat exchange member 20a is made to carry out conduction of the warm water through Piping 22a and 23a. This warm water can use what is discharged as thermal wastewater at works. Moreover, the interior of heat exchange member 20b is made to carry out conduction of the cooling water through Piping 22b and 23b. This cooling water can use the about 29-degree C water supplied from a cooling tower.

[0023] If it does so, the interior of an evaporator 32 and housing 21b will be open for free passage, the adsorption material by which the refrigerant steam which evaporated with the evaporator 32 was formed in the outside surface of heat exchange member 20b will be contacted, and adsorption material will be adsorbed in a refrigerant steam. As a result of moisture's adsorbing in the adsorption material of this heat exchanger 20b, in an evaporator 32, evaporation advances further. In this case, since cooling water is carrying out conduction of the interior of heat exchanger 20b and heat exchanger 20b is cooled, even if generation of heat arises by the adsorption reaction of adsorption material, since adsorption material is cooled, adsorption effectiveness does not fall.

[0024] Thus, as a result of evaporation advancing with an evaporator 32, water is cooled by the latent heat of vaporization and cold water is manufactured.

[0025] On the other hand, since thermal wastewater is carrying out conduction of the interior in heat exchange member 20a, the adsorption material is heated and adsorption material carries out desorption of the moisture to which it was sticking at low temperature comparatively to the bottom of a vacuum. Since housing 21a is open for free passage with the condenser 33, it is cooled with a condenser 33 and moisture condenses the refrigerant steam which carried out desorption from adsorption material. In heat exchanger 20a, the desorption of moisture advances further by condensation of this moisture, and adsorption material is reproduced.

[0026] Thus, after playback of adsorption material is completed in heat exchange member 20a and water adsorption is completed in heat exchange member 20b, the closing motion valves 26a and 27b are made open, and the closing motion valves 26b and 27a are made close. If it does so, an adsorption process will be carried out in heat exchange member 20a, and a playback process will be carried out in heat exchange member 20b. Thus, cold water is continuously manufactured from an evaporator 32 by carrying out a playback process and an adsorption process by turns by the heat exchange members 20a and 20b.

[0027] In this example, since the heat exchange member 20 (20a, 20b) has a fin 12 like drawing 1 and the adsorption material 13 is formed also in this fin 12, an adsorption area is large, it is efficient, and moisture adsorbs. Moreover, in an adsorption process, since cooling water carried out conduction of the interior of the heat exchange member 20 and

adsorption material is cooled, even if generation of heat by the adsorption reaction arises, adsorption effectiveness does not fall and high adsorption effectiveness is maintained. Consequently, according to the adsorption equation refrigerator of this example, it is very efficient and cold water can be obtained. For this reason, a coefficient of performance is high.

[0028] Next, drawing 1 and the adsorption equation refrigerator shown in 2 are actually manufactured, and the result of having asked for the coefficient of performance is explained. The fin pitch of this heat exchange member is 3.5mm. The heating area of each heat exchange member is 2.29m, and the change of a closing motion valve, i.e., the change to a playback process and an adsorption process, is for 5 minutes. The acrylic adhesiveness binder was applied all over the plate fin made from aluminum, and 680g /of silica gels whose grain size is 20 thru/or 35 meshes was pasted up on the front face two times m. A heat carrier is 75-degree C thermal wastewater, and the cooling water of the medium inside the heat exchange tubing 1 is cooling tower water.

[0029] Consequently, that that whose warm water was 75 degrees C at the entrance fell to 70 degrees C at the outlet, and cold water's was [that] 14 degrees C at the entrance fell to 12 degrees C at the outlet. The heating value by the side of warm water was 63kW, and the heating value by the side of cooling water was 82.5kW. Consequently, coefficients of performance were $82.5 / 63 = 1.31$.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the mimetic diagram showing the heat exchange member of the adsorption equation refrigerator concerning the example of this invention.

[Drawing 2] It is the block diagram showing the adsorption equation refrigerator of this example similarly.

[Drawing 3] It is the block diagram showing the conventional adsorption equation refrigerator.

[Drawing 4] It is drawing showing the **** diagram similarly.

[Description of Notations]

1; evaporator

2; condenser

3 4; heat exchanger

7; adsorption material

8; refrigerant

11; heat exchange tubing

12; fin

13; adsorption material

20, 20a, 20b; heat exchange member

21a, 21b; housing

32; evaporator

33; condenser

[Translation done.]

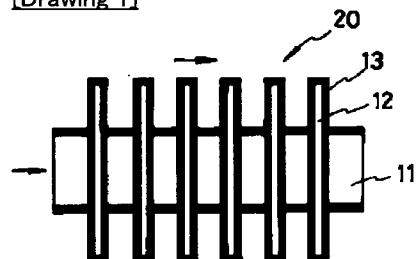
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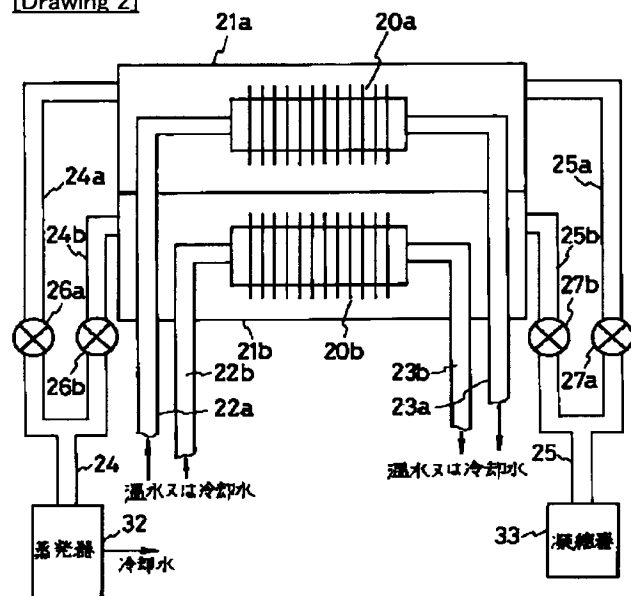
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DRAWINGS

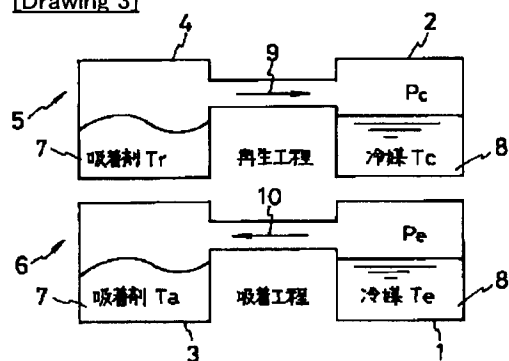
[Drawing 1]



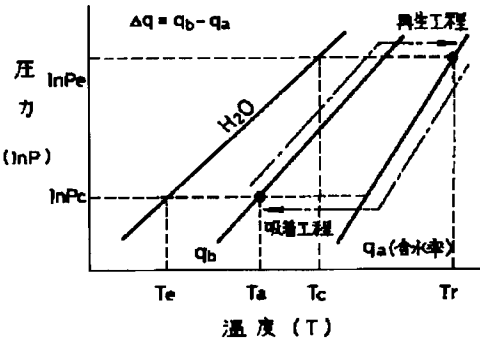
[Drawing 2]



[Drawing 3]



[Drawing 4]



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(71) 出願人 000001199

株式会社神戸製鋼所

兵庫県神戸市中央区脇浜町1丁目3番18号

(72) 発明者 岩本 宏之

神奈川県藤沢市宮前字裏河内100番1 株

式会社神戸製鋼所藤沢事業所内

(72) 発明者 高垣 昌和

神奈川県藤沢市宮前字裏河内100番1 株

式会社神戸製鋼所藤沢事業所内

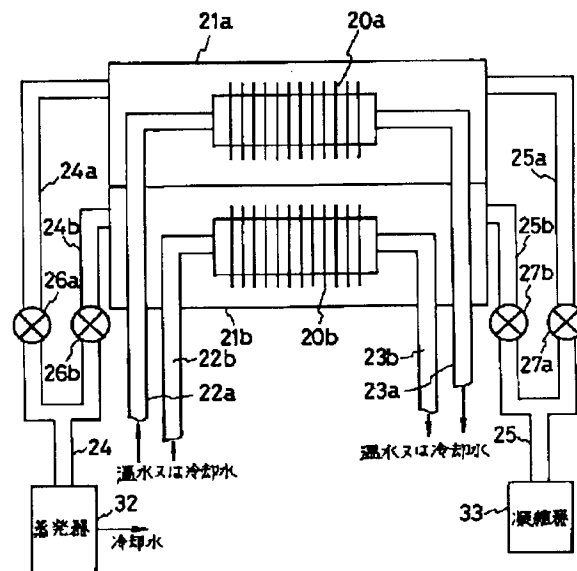
(74) 代理人 弁理士 藤巻 正憲

(54) 【発明の名称】 吸着式冷凍機

(57) 【要約】

【目的】 ランニングコストが低いという吸着式冷凍機の利点を生かしつつ、成績係数を向上させて効率を向上させることができる吸着式冷凍機を提供する。

【構成】 熱交換部材20のフィンを含む外表面部分に水分吸着材が配置されており、一方の熱交換部材20bの外表面部分に蒸発器32から蒸発した空気を接触させて水分を吸着する。このとき発生する吸着熱は熱交換部材内を通流する冷却水により除去する。一方、他の熱交換部材20aの内部には温排水を通流させて加熱し、吸着材を脱着する。脱着した水分を含む空気は凝縮器33にて凝縮する。この熱交換部材20a、20bにおける再生工程と吸着工程とを交互に実施することにより、蒸発器32にて連続的に冷水を製造することができる。



【特許請求の範囲】

【請求項1】 外表面部分に水分吸着材が配置された筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気を凝縮する凝縮器と、を有することを特徴とする吸着式冷凍機。

【請求項2】 外表面部分に水分吸着材が配置された少なくとも2基の筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気含有再生ガスを凝縮する凝縮器と、前記熱交換部材を2群に分け前記熱交換部材に対する外側蒸気及び内側冷却流体の供給と前記熱交換部材に対する内側熱媒流体の供給及び外側再生ガスの抽出とを交互に実施する制御手段と、を有することを特徴とする吸着式冷凍機。

【請求項3】 前記熱交換部材はその外表面に複数のフィンを設けられており、このフィンの表面も前記熱交換部材の前記外表面を構成していることを特徴とする請求項1又は2に記載の吸着式冷凍機。

【請求項4】 前記吸着材は、シリカゲル、ゼオライト、活性アルミナ及び活性炭からなる群から選択した少なくとも1種であることを特徴とする請求項1又は2に記載の吸着式冷凍機。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は低圧の密閉容器内での冷媒の蒸発潜熱を利用し、発生した冷媒蒸気を吸着材に吸着させ、連続して冷媒を蒸発させて冷熱を得る吸着式冷凍機に関し、特にプレートフィン型熱交換素子、シェルアンドチューブ型熱交換素子及びエロフィン型熱交換素子等の熱交換部材を使用して約5℃以上の冷水を製造するのに有効な吸着式冷凍機に関する。

【0002】

【従来技術】 冷水を製造する手段として、蒸気圧縮式冷凍機を使用して冷媒が蒸発するときの蒸発潜熱により冷水を製造する技術と、吸収式冷凍機を使用して低温で水が蒸発するように減圧した容器内で水を蒸発させてその蒸発潜熱により冷水を製造する技術と、シリカゲルのペレットを吸着材として吸着式冷凍機により冷水を製造する技術とがある。

【0003】 従来、冷水の製造には、蒸気圧縮式冷凍機が一般的に使用されているが、この蒸気圧縮式冷凍機は

フロンを使用しているため、近時の脱フロンの要請に反するものであり、また、凝縮熱が大きい水分を凝縮除去しようとするため、消費エネルギーが高いという問題点がある。

【0004】 一方、吸収式冷凍機はフロンの問題は生じないものの、蒸気圧縮式冷凍機に比して、効率が悪く、この冷凍効率を上げようすると、約8kgf/cm² Gの高圧蒸気が必要になる。このような高圧蒸気の供給装置は設置場所が制約されてしまい、蒸気圧縮式冷凍機に比して装置が大型化し、メンテナンスが難しいという難点がある。

【0005】 吸着式冷凍機は吸着材にシリカゲルを使用しているため、吸収式冷凍機に比して効率が悪いものの、工場及びコ・ジェネレーションシステム等の温排水を使用することによりランニングコストが極めて低くなり、また脱着時の温水温度の変動による効率の変化が少ないという利点がある。

【0006】 この吸着式冷凍機は、図3に示すように、吸着工程を実施する蒸発器1と吸着材熱交換器3とが、また再生工程を実施する凝縮器2と吸着材熱交換器4とが気密的に連結され、高真空に保持されるようになっている（クリーンエネルギー1993年2月号第35乃至40頁）。熱交換器3、4が2基設けられているが、これらはいずれも再生工程と吸着工程とが交互に実施され、それにより蒸発器1又は凝縮器2に交互に連結されるようになっている。蒸発器1の内部には、温度がT_eの冷媒8が存在し、凝縮器2には温度がT_cの冷媒8が存在する。この冷媒は水である。また、吸着材熱交換器3、4内には吸着材7が貯留されているが、再生工程の吸着材熱交換器4内の吸着材7は温度がT_r、吸着工程の吸着材熱交換器3内の吸着材7の温度はT_aである。この吸着材はシリカ系固体吸着材である。

【0007】 再生工程では、吸着材熱交換器4の吸着材7は熱源から熱を受けてその温度がT_aからT_rに上昇し、吸着していた冷媒が水蒸気となって脱着され、この水蒸気が凝縮器2にて凝縮温度T_c（圧力P_c）で水となる。この操作により、図4に示す等吸着量線図において、吸着材の含水率がq_bからq_aに移行する。

【0008】 また、吸着工程においては、吸着材熱交換器3内の吸着材7は冷却水等により温度がT_rからT_aになるまで冷却されることにより、吸着材の飽和含水率がq_aからq_bに増加するため、冷媒は系外から熱を奪い、蒸発器1において、蒸発温度T_e（圧力P_e）で気化し、吸着材7に吸着される。また、吸着時に発生する吸着熱は冷却水に奪われるようになっているため、吸着材7は温度がT_aに保持され、連続的に冷媒が吸着材7に吸着される。このような工程を2基の熱交換器3、4が交互に繰り返すことにより、蒸発器1から連続的に冷水が得られる。

【0009】

【発明が解決しようとする課題】しかしながら、この従来の吸着式冷凍機は、冷水製造効率が低いという難点がある。例えば、冷水条件を、冷水入口で14℃、冷水出口で12℃、冷凍能力を10USRT (30240kcal/H)、冷却水入口温度を29℃、温水入口温度を75℃、蒸気を8kgf/cm²Gとすると、蒸気圧縮式冷凍機の場合には、圧縮機容量が7.5kW、最大流量を12m³/時として、成績係数COPが3.4と優れている。なお、この成績係数は、冷凍機において、熱量Qをくみ上げるのに、どれだけの仕事Wを消費するかという指標であり、冷凍機の効率を表すものである。但し、この蒸気圧縮冷凍機においては、圧縮機を駆動するのに電力が必要であり、このための発電効率を考慮すると、成績係数COPは1程度となると考えられる。一方、吸収式冷凍機は蒸気消費量が45kg/時であり、成績係数は1.2である。

【0010】これに対し、吸着式冷凍機は成績係数が0.56と、蒸気圧縮式冷凍機及び吸収式冷凍機に比して極めて低い。

【0011】本発明はかかる問題点に鑑みてなされたものであって、ランニングコストが低いという吸着式冷凍機の利点を生かしつつ、成績係数を向上させて効率を向上させることができる吸着式冷凍機を提供することを目的とする。

【0012】

【課題を解決するための手段】本発明に係る第1の吸着式冷凍機は、外表面部分に水分吸着材が配置された筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に流通させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を流通させる冷却手段と、前記熱交換部材の内側に熱媒流体を流通させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気を凝縮する凝縮器と、を有することを特徴とする。

【0013】本発明に係る第2の吸着式冷凍機は、外表面部分に水分吸着材が配置された少なくとも2基の筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に流通させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を流通させる冷却手段と、前記熱交換部材の内側に熱媒流体を流通させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気含有再生ガスを凝縮する凝縮器と、前記熱交換部材を2群に分け前記熱交換部材に対する外側蒸気及び内側冷却流体の供給と前記熱交換部材に対する内側熱媒流体の供給及び外側再生ガスの抽出とを交互に実施する制御手段と、を有することを特徴とする。

【0014】この場合に、前記熱交換部材には、その外表面に複数個のフィンが設けられており、このフィンの

表面も前記熱交換部材の前記外表面を構成しているものであることが好ましい。

【0015】また、前記吸着材としては、シリカゲル、ゼオライト、活性アルミナ又は活性炭がある。

【0016】

【作用】本発明においては、筒状の熱交換部材の外表面に吸着材を設け、熱交換部材の内部に熱媒流体又は冷却流体を流通させて、熱交換部材の外表面の吸着材を加熱し、又は冷却する。これにより、例えば75℃の温排水等の熱媒流体が流通している熱交換部材においては、吸着材が加熱されて再生工程が実施され、水分が脱着される。この脱着水分は蒸気となって凝縮器に入り、凝縮器で冷却されて凝縮される。一方、蒸発器において発生した蒸気は、熱交換部材の吸着材に接触して流通し、その水分が吸着材に吸着される。蒸発器においては、蒸発潜熱を奪われて冷却された冷水が得られる。この吸着工程においては、熱交換部材の内部に冷却流体を流通させるので、吸着熱により吸着材が昇温して吸着効率が低下するということなく、常時高効率で吸着工程が実施される。このように、本発明においては、筒状の熱交換部材の外表面側と内側とで熱交換が実施されて吸着工程と再生工程とが交互に実施されると共に、この吸着工程においては、吸着材が冷却流体により冷却されているので、吸着効率が高い。従って、極めて優れた冷凍効率を得ることができ、成績係数を向上させることができる。

【0017】

【実施例】以下、本発明の実施例について添付の図面を参照して具体的に説明する。図1は本発明の実施例に係る吸着冷凍機の熱交換部材20を示す正面図である。熱交換管（銅管）11には、複数のアルミニウムプレートフィン12が嵌合されている。そして、これらの銅管1の外周面及びフィン12の表面の全面に、水分吸着材13が配置されている。この吸着材13は、例えば銅管11の外周面及びフィン12の表面の全面にアクリル粘性バインダを塗布し、このアクリル粘着材バインダ膜にシリカゲル粒子を埋め込むようにして、添着することにより形成することができる。また、シリカゲルの粉末を水ガラスと共に混練し、これを銅管11の外周面及びフィン12の表面に押出して塗布した後、水ガラス分を乾燥焼成し、シリカゲル粉末と水ガラスをフィン表面等に固着することにより吸着材を設けることができる。いずれにしても、吸着材の粉末又は粒子を熱交換部材の表面に塗布し、又は接着することにより、固着すればよい。吸着材としては、シリカゲルの外に、ゼオライト、活性炭及び活性アルミナ等がある。

【0018】また、図1に示す熱交換部材はプレートフィン型の熱交換素子であるが、このようなタイプのものに限らず、シェルアンドチューブ型又はエロフィン型の熱交換素子等を使用することもでき、更にフィンを有しない単管状の熱交換素子を使用してもよい。

【0019】本実施例の吸着式冷凍機はこの熱交換部材20(20a、20b)を使用して図2に示すように構成されている。各熱交換部材20a、20bは夫々ハウジング21a、21b内に気密的に収納されており、これらの熱交換部材20a、20bの内側には配管22a、22bを介して温水又は冷却水が供給されるようになっている。この温水又は冷却水は熱交換部材20a、20bの内部を通流して熱交換部材20a、20bを加熱し又は冷却した後、配管23a、23bを介して排出される。これらの配管22a、22b、23a、23bはハウジング21a、21bの外部に導出されている。

【0020】ハウジング21a、21b内に連通する配管24a、24bがハウジング21a、21bの一方の端部に連結されており、また、ハウジング21a、21bの他方の端部には配管25a、25bが連結されている。配管24a、24bはいずれも配管24に連結されており、ハウジング21a、21bはこれらの配管24、24a、24bを介して蒸発器32に連結されている。一方、配管25a、25bはいずれも配管25に連結されており、これらの配管25、25a、25bを介してハウジング21a、21bは凝縮器33に連結されている。

【0021】配管24a、24bには開閉弁26a、26bが設けられており、配管25a、25bには開閉弁27a、27bが設けられている。これらのハウジング及び配管はいずれも気密に保持されている。また、ハウジング21a、21b内は真空状態に保持されている。

【0022】次に、このように構成された吸着式冷凍機の動作について説明する。まず、熱交換部材20aが再生工程、熱交換部材20bが吸着工程を実施しているとす。開閉弁26a、27bを閉、開閉弁26b、27aを開にする。また、配管22a、23aを介して熱交換部材20aの内部に温水を通流させる。この温水は工場において温排水として排出されているものを使用することができる。また、配管22b、23bを介して熱交換部材20bの内部に冷却水を通流させる。この冷却水はクーリングタワーから供給される29℃程度の水を使用することができる。

【0023】そうすると、蒸発器32の内部とハウジング21b内部とが連通し、蒸発器32にて蒸発した冷媒蒸気が熱交換部材20bの外表面に設けられた吸着材と接触し、冷媒蒸気が吸着材に吸着される。この熱交換器20bの吸着材にて水分が吸着される結果、蒸発器32においては更に蒸発が進行する。この場合に、熱交換器20bの内部は冷却水が通流していて熱交換器20bが冷却されているので、吸着材の吸着反応により発熱が生じて、吸着材は冷却されているため、吸着効率が低下することはない。

【0024】このようにして、蒸発器32にて蒸発が進行する結果、蒸発潜熱により水が冷却されて冷水が製造

される。

【0025】一方、熱交換部材20aにおいては、その内部を温排水が通流しているので、その吸着材が加熱され、吸着材は吸着していた水分を真空下において比較的低温で脱着する。ハウジング21aは凝縮器33と連通しているので、吸着材から脱着した冷媒蒸気は凝縮器33にて冷却されて水分が凝縮する。この水分の凝縮により熱交換器20aにおいては、更に水分の脱着が進行し、吸着材が再生される。

【0026】このようにして、熱交換部材20aにて吸着材の再生が終了し、熱交換部材20bにて水分吸着が終了した後、開閉弁26a、27bを開、開閉弁26b、27aを閉にする。そうすると、熱交換部材20aにて吸着工程が実施され、熱交換部材20bにて再生工程が実施される。このようにして、熱交換部材20a、20bにて再生工程と吸着工程とを交互に実施することにより、蒸発器32から冷水が連続的に製造される。

【0027】本実施例においては、図1のように熱交換部材20(20a、20b)がフィン12を有し、このフィン12にも吸着材13が設けられているので、吸着面積が広く、高効率で水分が吸着される。また、吸着工程においては、熱交換部材20の内部を冷却水が通流して吸着材を冷却しているので、吸着反応による発熱が生じて吸着効率が低下することはなく、高吸着効率が維持される。その結果、本実施例の吸着式冷凍機によれば、極めて高効率で冷水を得ることができる。このため、成績係数が高い。

【0028】次に、実際に図1、2に示す吸着式冷凍機を製造し、成績係数を求めた結果について説明する。この熱交換部材のフィンピッチは3.5mmである。各熱交換部材の伝熱面積は29m²であり、開閉弁の切替、即ち再生工程と吸着工程との切替は5分間である。アルミニウム製プレートフィンの全面にアクリル粘着性パイプンダーを塗布し、その表面に粒度が20乃至35メッシュのシリカゲルを680g/m²接着した。熱交換管1の内部の媒体は熱媒体が75℃の温排水であり、冷却水がクーリングタワー水である。

【0029】その結果、温水は入口で75℃であったものが出口で70℃に低下し、冷水は入口で14℃であったものが出口で12℃に低下した。温水側の熱量は63kWであり、冷却水側の熱量は82.5kWであった。その結果、成績係数は、82.5/63=1.31であった。

【0030】

【発明の効果】以上説明したように、本発明によれば、吸着式冷凍機のランニングコストが低いという利点を生かしつつ、その成績係数を他の蒸気圧縮式冷凍機及び吸収式冷凍機の成績係数以上に高めることができる。このため、本発明は冷水を極めて高効率で製造することができるという優れた効果を奏する。

【図面の簡単な説明】

【図 1】 本発明の実施例に係る吸着式冷凍機の熱交換部材を示す模式図である。

【図 2】 同じく本実施例の吸着式冷凍機を示すブロック図である。

【図 3】 従来の吸着式冷凍機を示すブロック図である。

【図 4】 同じくその等吸着量線図を示す図である。

【符号の説明】

1；蒸発器

2；凝縮器

3、4；熱交換器

7；吸着材

8；冷媒

11；熱交換管

12；フィン

13；吸着材

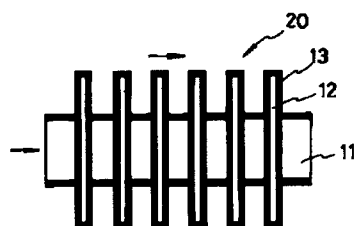
20、20a、20b；熱交換部材

21a、21b；ハウジング

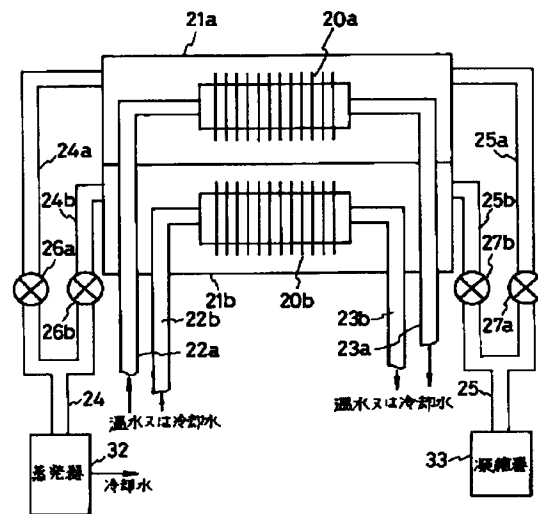
32；蒸発器

33；凝縮器

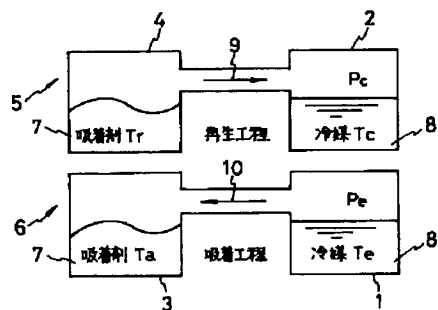
【図 1】



【図 2】



【図 3】



【図 4】

